

THE DIGESTION OF SPONGES EFFECTED BY
ECTODERM OR ENTODERM?

BY R. VON LENDENFELD, PH.D.

In my paper on the Australian Aplysinidæ (1) I gave an account of the experiments which I had carried on for the purpose of obtaining some information concerning the digestion in Sponges. The main result of these experiments was that the Epithel of the ciliated chambers is not to be considered as an organ of digestion, that all cells of the Sponge freely take up Carmine when in contact with them, and that therefore the cells of the Epithelia of Sponges kept in water containing Carmine were soon found full of Carmine granules, but that the Epithel of the ciliated chambers soon ejects the Carmine again whilst the cells of the upper surface of the subdermal cavity give it off to the amœboid wandering cells of the Mesoderm, and that these transmit the Carmine granules after they have been partly digested, to the cells of the ciliated chambers for ejection. I concluded from this that the digestive function of the Sponges which I experimented on was centralized in the upper wall of the subdermal cavities, and that in Sponges which do not possess a highly developed cavity of this kind the digestion was effected by the Epithelia of the *introductory* canal system.

According to F. E. Schulze (2) the introductory canal system of the Sponges is produced by a complicated folding process of the

(1.) *R. von Lendenfeld*. Cœlenteraten der Südsee II, Neue Aplysinidæ Zeitschrift für wiss. Zool. Band XXXVIII., Seite 252 ff

(2.) *F. E. Schulze*. Über den Bau und die Entwicklung der Spongien. Die Plakiniden. Zeitschrift für wiss. Zool. Band XXXIV., Seite 439.

whole, and is derived directly from the Ectoderm. Marshall (1) studied the Embryology of *Reniera filigrana* and came to results very different from those of Schulze, and in fact from anything published previously. Although there may be a few doubtful statements in this extremely interesting paper, statements which I have criticised (2) elsewhere, there are certainly also so many proofs brought forward to endorse them that it appears more than doubtful whether Schulze's statements hold good for Sponges similar to *Reniera*. According to Schulze (l.c.) the introductory canals are produced by the Ectoderm and are originally very short, they then break through the walls of the ciliated chambers and *afterwards* grow out to greater length. Granted that the centrifugal portion of the canal wall is really Ectodermal there is no proof that the same thing is the case in the inner and longer portion of the canal. It is apparently just as likely that the Epithel of the growing canal is produced from the lower end as that it is produced by a rapid multiplication of the cells at its exterior termination. In the case of *Reniera*, Marshall (l.c.) has proved that the introductory canal system is Ectodermal, and although, there is no doubt, that the centrifugal terminations of the introductory canals of *Plakina* are originally Ectodermal it is apparent from the above statements that the lower portion may also here be Entodermal.

At the time when I wrote my paper on the *Aplysinidæ*, I had not seen Marshall's paper, which was published at the same time, and I was accordingly not aware, that any one had made statements about the origin of the Epithelia of the introductory Canals different from those of Schulze (l.c.), which were at that time universally accepted. Accordingly, I concluded from the fact that the digestion in sponges took place in the introductory Canal system, and that this Canal system had an Ectodermal Epithel, that the *Sponges absorbed their nourishment by means of the Ectoderm*.

(1.) *W. Marshall*. Die Ontogenie von *Beniera filigrana* Zeitschrift für wiss. Zool. Band. XXXVII., Seite 227 ff.

(2.) *R. von Lendenfeld*. Monograph of the Australian Sponges. Proceedings of the Lin. Soc. N.S.W., Vol. IX.

This conclusion was somewhat similar to one which Balfour (1) had arrived at by reasoning only and without any actual proof.

If the Epithel of the introductory Canals is Entodermal, this conclusion is wrong, because in that case one of the premises is wrong. And further investigations will be required to settle the question of the correctness of these premises.

I have made up my mind to publish this explanation, because some authors have considered my conclusions as important, and that part of the premises which is the result of my experiments as of lesser importance. Polejaeff (2) has pointed out this fact in his recent excellent publication on the Calcareous Sponges of the Challenger Expedition.

Metschnikoff (3) in his highly important paper on Intracellular Digestion, has cited my observations as examples of Ectodermal digestion, but it appears from his statements, as if I had said that the *outer surface* of the Sponge absorbed nourishment, which I did not say.

Polejaeff (l.c.), remarks with great acuteness, that I should not have considered the "Keimblätter" in my argument, as it is not certain to which embryonic layers that Epithel belongs, by which in the case of the Aplysillidæ the greater part of its nourishment appears to be observed.

Polejaeff says in another place (4), that nourishment is absorbed by all the Canal surfaces, that the Epithelia of the Canals conducting hither and thither, are physiologically as similar as they are morphologically. This opinion is based upon four arguments. Two of these do not apply to the Aplysillidæ. Polejaeff states that the amœboid

(1.) *T. Balfour*. Handbuch der vergleichenden Embryologie, deutsch von Vetter. Band, I. Seite. 144.

(2.) *Polejaeff*. The Zoology of the Voyage of H. M. S. Challenger. Part XXIV., p. 14.

(3.) *E. Metschnikoff*. Untersuchungen über die intracelluläre Verdauung bei wirbellosen Thieren. Arbeiten aus den Zoolog. Inst. der Universität Wien. Band, V. Seite, 3. Translated into English. Quarterly Journal of mikr., Sc., Nr. 98.

(4.) *Polejaeff*. (l.c.), p. 15.

wandering cells are just as numerous below the Epithel of the Canals leading outwards, as underneath the Epithel of the Sub-dermal cavity. I do not doubt that this occurs in the Sponges which Polejaeff has examined. In the *Aplysillidæ* however, a centralisation towards the skin appears to have taken place together with the formations of a large Sub-dermal cavity, as only there a layer of thickly pressed wandering cells can be proved to exist.

Polejaeff says further (l.c.), there "is no room for the supposition that all nourishment is absorbed by the Sub-dermal cavity Epithel." Although I am quite willing to acknowledge that other portions of the Epithel are able to absorb nourishment, just as the outer skin of a man can absorb substances. I must conclude from my observations, that, in fact, by far the greater part of the nourishment in the case of the *Aplysillidæ* is absorbed in the Sub-dermal cavity. Following Marshall's example, I avoid any generalisation, and I do not doubt, that Polejaeff as well as myself are both right, but that we have arrived at different results in some trifling particulars, because we have examined different Sponges.

We can now discern concerning the digestion of Sponges what probably is correct, and which statements are doubtful. The views expressed in my paper on the Australian *Aplysinidæ* (l.c.) are very different from those expressed by Carter, who is of opinion, that the cells of the ciliated chambers are those to which digestive functions are to be ascribed.

This, as Polejaeff (l.c.) remarked from a mechanical point of view, is a very unlikely hypothesis and can be considered as discredited by my observations. And I think that my scientific colleagues universally agree to my statement that the nourishment is absorbed in the canals and not in the ciliated chambers. Whilst in the *Aplysillidæ* the introductory canals effect the absorption of nourishment in a higher degree than the drainage canals; in some other Sponges such a difference does not occur. (Polejaeff l.c.)

The introcellular digestion, discovered by Lieberkühn (1) and Metschinkoff (2) is probably effected by the amœhoid wandering cells, whilst only the epithelial cells have the function of *transmitting* the nourishing material to them.

Lieberkühn's, Metschinkoff's and my own experiments were made with Carmine and not with nearly nourishing material, so that these conclusions are open to a little doubt as Metschinkoff (3) remarks. His statements based on a series of most interesting experiments, however, make it probable that in the Sponges the nourishment is treated similarly to the Carmine granules.

The question whether the Sponges digest with the Ectoderm or with the Entoderm cannot yet be decided. But it does not appear improbable that both layers (Polejaeff l.c.) may have that function. The Keimblätter of other Cœlenterata are nearly analogous, so that we can conclude that the layers of the much less highly organised Sponges are still more so, and that we have in the Sponges *indifferent germinal layers before us*.

(1.) *Lieberkühn*. Beitrag zur Entwicklungsgeschichte der Spongillen. Müller's Archiv. Band 1836, Seite 385 ff.

(2.) *E. Metschinkoff*. Spongiologische Studien, Zeitschrift für wis. Zool. Band XXXII., Seite 371-374.

(3.) *E. Metschinkoff*. Ueber die Introcelluläre Verdauung bei wirbellosen Thieren. Arbeiten aus den Zool. Inst. d. Universität Wien, Band V., Seite 25, 26 u.o. O.